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OPTICAL VIEWING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This invention claims priority of the German patent application 100 64 910.6 which is incorporated by reference herein.

FIELD OF THE INVENTION

The invention concerns an optical viewing device in which image data are reflected in, for example a surgical (stereo)microscope.

BACKGROUND OF THE INVENTION

Overlaying of data, or the superimposition of data by means of reflecting-in devices, into the observation field of optical systems is being used more and more in many sectors, since it results in a considerable gain in information for the user. In clinical applications, reflecting-in systems give the surgeon the possibility of receiving further visual information without interrupting his or her visual contact with the surgical field. This is typically done by overlaying additional data onto the microscopic intermediate image, for example by means of a display, imaging optical system, and optical beam splitter.

In almost all applications, the brightness, contrast, and resolution of the overlaid image are important quality features for proper functionality. For good perception of the overlaid information, the image signal that is reflected in must, as a rule, be significantly brighter than the optical image of the specimen seen through the eyepiece.

In reflecting-in devices known at present, the reflected-in image data are presented in the form of an overlay, with simultaneous or alternatingly exclusive depiction of the reflected-in image data in the observation field of a surgical (stereo)microscope. A separate illumination device is usually provided for the display for the reflected-in image. This device can be regulated only if it comprises additional diaphragms with the corresponding control elements, electrical controllers, or the like. If the brightness of the reflected-in image is not controlled, unsatisfactory overlaid images result.

For simultaneous overlaying of the image data onto the specimen image, the amount of light required is much greater than the already large amount of light for specimen illumination.

The inventor has recognized that the known systems are disadvantageous in terms of the following aspects:

i) Because of the high light intensity, very fine detail distinctions in the specimen image are not detected because of the occurrence of flare, reflections, and therefore the obliteration of visual data.

ii) If the available image information is viewed by a viewer directly, i.e. without the image coming from the specimen, the amount of light used is generally too great and the viewer is dazzled, or the brightness of the illumination for the reflected-in image must be readjusted manually.

iii) In many cases in which a control capability exists, switching between overlay mode and exclusive viewing of the reflected-in image data is implemented only via regulation of the high-intensity main specimen illumination system, which is associated with known disadvantages such as changes in color temperature in the specimen image or the reflected-in image.

iv) All presently known methods for controlling the light intensity of a reflected-in image use a constant intensity over the entire area of the reflected-in image data.

SUMMARY OF THE INVENTION

It is therefore the object of the invention to find an improvement which eliminates the aforesaid disadvantages and makes possible undisturbed, continuous viewing of the reflected-in information, independently of

a) whether the viewer is viewing exclusively the reflected-in image or the overlay; and of

b) the brightness and contrast with which a specimen is being imaged.

This object is achieved by

a) the utilization of a second light source (of lower intensity) for the reflected-in image data, which can be selectably superimposed or removed;

and/or

b) the use of specimen light reflections as the light source for the reflected-in image data. This invention can also be utilized independently of invention a).

and/or

c) The use of a portion of the specimen light illumination for the reflected-in image data. This invention can also be utilized independently of inventions a) and b).

A distinction is also made as to whether, in the context of the invention,

a) a transmitted-light display, for example an LCD display;

or

b) an incident-light display, for example a D-ILA display

is used for the reflected-in image data.

The use of a D-ILA display for reflecting in the image data is novel per se, and according to the present invention is usable, especially given the particularly good brightness, independently of the other features recited.

In the steps below, the following improvements can therefore be achieved:

i) The second light source allows the reflected-in image data to be adjusted as desired in terms of intensity and color.

ii) Because the light of the main light source reflected from the specimen is used, it is possible, as in the configuration defined in c), to regulate the reflected-in brightness automatically together with the specimen brightness. According to a particular embodiment of the invention, the brightness of the reflected-in image data can even be adapted in point fashion (pixel by pixel) as a function of the ambient brightness or contrast of the specimen. This yields, for the first time, automatic regulation of the reflected-in brightness for every portion of the overlaid image. At a dark point on the specimen, for example, the reflected-in image overlaid there will appear as only a faint image.

iii) When the method listed under b) is used, the use of a light amplification system for linear intensity modification over the entire reflected-in image is also possible.

iv) The overall result of using one of the three new methods is to eliminate flare, glare, and obliteration of the specimen image.

v) Relative color temperature changes do not occur in either the specimen image or the reflected-in image, since a system for controlling the current intensity of the reflected-in image can be dispensed with.

vi) When the method listed under a) is used, it is possible not only to adapt the brightness of the reflected-in image to the particular specimen brightness, but also to adapt the color; for example, a color contrasting with the particular specimen image is used for the reflected-in image.

Reference is made in the text above to a surgeon and to a surgical microscope and surgical field, but the invention is not limited thereto; rather it is also open to other users of optical devices with reflected-in images (e.g. projected images with additional information superimposed, video and photographic cameras, monocular and binocular applications). The patent claims are to be formulated correspondingly broadly.

The Parts List and Figures 1,2, 3a, and 3b, together with the subject matter described and protected in the Claims, are integral constituents of the disclosure of this Application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 symbolically shows a main illuminating beam path 1 and a main beam path 2, 6 of a viewing device and an illuminating beam path 3 for a reflected-in image, proceeding from a main light source 11 via a beam splitter 16 to a deflection unit 17, for example a (tiltable, pivotable, or rotatable) prism 7. According to the present invention, an additional reflected-in image illuminator 18 (preferably controllable as to brightness and color temperature), a transmitted-light display 21, and the resulting reflected-in image beam path 4 are depicted; the

latter is in turn superimposed via a beam splitter 23 into the main beam path for observation. Eyepiece optical system 14 focuses both the reflected-in image and the specimen image onto the eye of viewer 15. The light of main light source 11 or the light of reflected-in image illuminator 18 can thus be used selectably to illuminate display 21. What is particularly novel and inventive about this configuration is thus the switching element, for example a prism 7, that creates a selection between two possibilities with no movement of the light sources.

FIG. 2 shows, according to the present invention, the use of light 2, 6 reflected from the specimen as illumination for transmitted-light display 21, which is divided by way of a beam splitter 24 into an illuminating beam path 3 for the reflected-in image and viewer beam path 6. According to a particular embodiment of the invention, the image of specimen 13 is then imaged at least approximately on display 21 in order to optimize the pixel brightness of the display illumination.

FIG. 3a shows, according to the present invention, the use of a reflected-light or incident-light display 32 **[?36]**, for example a D-ILA, utilizing illuminating beam path 3 for the reflected-in image via a deflection unit 31, for example a prism. Alternatively, light from the main light source could be directed via beam splitter 23 directly onto the incident-light display, so that prism 23 is eliminated. Furthermore, an additional illuminator 18 can be provided that sends light, in addition or alternatively to the main light source, onto incident-light display 32.

FIG. 3b shows, according to the present invention, the use of a reflected-light or incident-light display 32 **[?]** that uses reflected specimen light 2, 6 as the illumination source. If specimen 13 is imaged at least approximately on the display, this results in pixel-scale illumination control. It is understood as self-evident that beam path 2b can comprise a built-in beam splitter, a diaphragm, or the like in order to keep the light intensity of the specimen image at the same level as in beam path 2a with a prism 23 or 33.

In both FIG. 3a and FIG. 3b, reflection of the image into main beam path 6 is accomplished via a splitter prism 23 or 33, respectively.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1:

A portion of the light proceeding from main light source 11 is deflected by beam splitter 16 onto tiltable deflection unit 17, for example a prism, mirror, or the like, **[and]** onto transmitted-light display 21. The image produced on display 21 is overlaid on main beam path 6 using a beam splitter. According to the present invention, a second light source 18, to be used separately for the reflected-in image, can be used to illuminate display 21 via an illuminating beam path 5 to illuminate the display **[sic]**; this makes possible control of the brightness and/or color temperature of the reflected-in image independently of main light source 11.

FIG. 2:

Instead of main light source 11, light 2, 6 reflected from specimen 13, which is directed by a splitter prism 24 onto deflection unit 17, is used for display illumination. The basic brightness can be reduced by means of a shutter 19; the sharpness of the reflected-in image can be reduced by means of a diffusion unit 25, for example a diffusion disk. According to the present invention, by means of this arrangement it is possible to dispense with control systems for the brightness of portions of the reflected-in image, since this **[sic]** the light reflected from the specimen assumes this function. Combinations of reflected light and an additional light source 18 are within the context of the invention as variants.

FIGS. 3a, 3b

In FIGS. 3a and 3b, according to an independent invention, instead of transmitted-light display 21 depicted in FIGS. 1 and 2 a reflective display 32, which is

illuminated either by main light source 11 via a beam splitter 16 and a deflection prism 31 (FIG. 3a) or by light 2, 6 reflected from specimen 13 via a splitter prism 33 (FIG. 3b), is used. The image is reflected in at reflective surfaces 34 and 36 in splitter prism 33. This arrangement is particularly suitable especially because of its brightness. It can also be used independently of the other features described.

PARTS LIST

1 Main illumination beam path
2 Specimen beam path
3 Illuminating beam path of main light source for reflected-in image
4 Beam path of reflected-in image
5 Beam path **[?of ?from]** additional light source for reflected-in image
6 Main beam path
7 Switchover arrow **[sic]**

11 Main light source
12 Main objective
13 Specimen
14 Eyepiece optical system
15 Viewer
16 Illumination beam splitter for main light source
17 Deflection unit (tiltable), e.g. prism or mirror
18 Light source for reflected-in image, e.g. LEDs
19 Superimposition shutter (diaphragm)

20 Display optical system
21 Transmitted-light display (e.g. LCD)
22 Optical system for reflected-in image
23 Beam splitter for superimposing reflected-in image
24 Illumination beam splitter for reflected specimen light
25 Diffusion element (e.g. diffusion disk)

31 Deflection prism for reflected-in image illumination
32 Reflective display (e.g. D-ILA display)

33 Deflection prism for reflected-in image illumination and for reflecting image into main beam path

34 Reflection surface for reflected-in image

35 Splitter surface for reflected specimen light

36 Shutter

37 Reflective pixel electrode (signal / driver IC / polarized layer)

38 Liquid crystal layer

39 Transparent electrode

40 Glass